



# National Institute of Standards & Technology

## Certificate

### Standard Reference Materials®

2092 - Low-Energy

2096 - High-Energy

2098 - Super High-Energy

#### Verification Specimens for Charpy V-Notch Impact Machines

Lot No.:

Standard Reference Materials (SRMs) 2092, 2096, and 2098 are intended primarily for the verification of Charpy V-Notch machines in accordance with the current ASTM Standard E23 [1]. Each SRM consists of a set of individual 10 mm x 10 mm x 55 mm specimens needed to perform one verification. These SRMs comply with both ASTM Standard E23 and International Organization for Standardization ISO/DIS 12736 dimensional requirements [2].

**Material Description:** SRMs 2092 and 2096 are made from 4340 alloy steel. SRM 2098 is made from a high strength maraging steel. The bars are finished to length, stamped, heat-treated, and machined in SRM specimen lots of approximately 1200. Each specimen has a lot number and an identification number (three or four digits) stamped on one end of the specimen. Additional information can be found in references 3-5.

**SRM Certification Procedure:** Specimens taken at random from each SRM lot are tested by the NIST Materials Reliability Division on Charpy V-Notch reference machines. The specimen data generated are then statistically evaluated to assure the homogeneity of the lot, establish the certified value, and determine the number of SRM specimens required for a user to perform a valid test. See Table 1 for a list of the approximate energy ranges within which the individual certified values should fall.

If certified values are required immediately after testing, contact the NIST Charpy Program Coordinator: telephone (303) 497-3351; fax (303) 497-5939; or e-mail [charpy@boulder.nist.gov](mailto:charpy@boulder.nist.gov). The lot number and energy results of the tested specimens must be provided in order to obtain certified values by telephone or fax.

**Expiration of Verification:** The verification report issued on an acceptable machine is valid for one year from the date that the SRM was tested. If a user's machine is moved or undergoes any major repairs or adjustments, the current verification will be invalidated, and the machine must be retested and reverified.

The overall direction and coordination of the technical measurements leading to verification of test specimens and machines, evaluation of test results, and issuance of the report on machine conformance are under the direction of the NIST Materials Reliability Division, Boulder, CO.

The support aspects involved in the original preparation, certification, and issuance of these SRMs were coordinated through the NIST Standard Reference Materials Program by R.J. Gettings. Revision of this certificate was coordinated through the NIST Standard Reference Materials Program by C.R. Beauchamp.

Alan F. Clark, Chief  
Materials Reliability Division

Gaithersburg, MD 20899  
Certificate Issue Date: 18 November 2003  
*See Certificate Revision History on Last Page*

John Rumble, Jr., Chief  
Measurement Services Division

**NOTE: THESE ARE NOT CERTIFIED VALUES. THESE ARE THE APPROXIMATE RANGES FOR EACH ENERGY LEVEL.**

Table 1. Approximate Charpy SRM Energy Ranges

SRM No.	(J)	(ft·lbf)
2092	13 - 20	10 - 15
2096	88 - 136	65 - 100
2098	176 - 244	130 - 180

**Storage:** The SRMs are comprised of specimens anticipated to have an indefinite shelf life under normal storage conditions. Each specimen is coated with oil, wrapped in a corrosion inhibiting paper, and sealed in a plastic envelope. It is recommended that the specimen be retained in this package to protect them from moisture until used. The protective oil coating should be wiped from each specimen just prior to testing.

#### **INSTRUCTIONS FOR USE:**

Prior to testing a Charpy V-Notch machine, the machine should be checked to assure compliance with the appropriate sections of the current ASTM Standard E23 [1]. To comply with the testing procedures specified in the standard, SRM 2092 and SRM 2096 shall be tested at  $-40\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$  ( $-40\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$ ). SRM 2098 shall be tested at  $21\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$  ( $70\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$ ). All SRM specimens are to be tested in accordance with the testing procedures of the appropriate sections of the current ASTM Standard E23. All SRMs shall be tested at the same time. An acceptable machine will produce an average value within 1.4 J (1.0 ft·lbf) or 5 % of the certified energy value, whichever is greater, providing the specimens appear to have normal markings. Because the source(s) and magnitude of error for energy values at one energy level may not be the same at different energy levels, calibration or correction curves shall not be used.

**Verification of User's Machine:** The NIST Charpy Program Coordinator will issue a report of findings to the user's facility upon receipt of the fractured specimens and completed questionnaire, "Questionnaire for Charpy Impact Machine Verification". If the machine to be verified produces acceptable values and the specimens appear to have normal markings, this report will verify its conformance. If the machine produces values outside the allowable tolerance of the certified energy values or the specimens have abnormal markings, the report may suggest repair or replacement of machine parts, changes in testing techniques, or other appropriate corrective actions. Fractured specimens and completed questionnaires should be returned to the NIST Charpy Program Coordinator, Mail Code 853.07, 325 Broadway, Boulder, CO 80305-3328. A plastic, self-locking bag is provided for the return of broken specimens. The broken specimens shall be taped together as described in the wrapping instructions included with the questionnaire.

**Important Information:** Shipping charges for the return of broken specimens are the responsibility of the user. The mailing label provided with each SRM must be used to expedite shipping and, for overseas shipments, clearance by U.S. Customs.

**Note to International Customers:** Regular overseas shipments of broken specimens should be sent airmail so that after they are cleared by U.S. Customs, they can be forwarded directly to NIST-Boulder. If a more rapid shipping mode is necessary, choose an overnight delivery service that will handle U.S. Customs clearance **AND** will deliver directly to NIST-Boulder. Unless such delivery is assured, air freight packages may be returned to the customer by U.S. Customs.

## REFERENCES

- [1] ASTM E23, Standard Test Methods for Notched Bar Impact Testing of Metallic Materials, **Annual Book of ASTM Standards**, Vol. 03.01, ASTM, West Conshohocken, PA.
- [2] ISO/DIS 12736, Metallic Materials - Impact Testing - Preparation and Characterization of Charpy V Reference Test Pieces for Verification of Pendulum Impact Testing Machines, ISO, Geneva, Switzerland.
- [3] Siewert, T.A.; Schmieder, A.K.; *Pendulum Impact Machines: Procedures and Specimens for Verification*, ASTM STP 1248, ASTM, West Conshohocken, PA (1995).
- [4] Shepherd, D.A.; Siewert, T.A.; *Interlaboratory Test Study for the Determination of Precision and Bias in Charpy V-Notch Impact Testing*, ASTM Research Report E28-1014, ASTM, Philadelphia, PA, (1991).
- [5] Holt, J.M.; *Charpy Impact Test - Factors and Variables*, ASTM STP 1072, ASTM, Philadelphia, PA (1990).

<p><b>Certificate Revision History:</b> 07 November 2003(update contact information); 14 May 2001 (updated email address for Boulder contact); 09 August 2000 (updated mail and zip codes for Boulder facility); 22 March 2000 (editorial revision); 26 July 99 (editorial revision); 20 February 97 (original certificate date).</p>
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*Users of this SRM should ensure that the certificate in their possession is current. This can be accomplished by contacting the SRM Program at: telephone (301) 975-6776; fax (301) 926-4751; e-mail [srminfo@nist.gov](mailto:srminfo@nist.gov); or via the Internet <http://www.nist.gov/srm>.*

## QUESTIONNAIRE FOR CHARPY IMPACT MACHINE VERIFICATION

**IMPORTANT:** This questionnaire contains information to help you perform a successful verification test using SRMs 2092, 2096, or 2098. Energy results are required for verification. Other specific information is requested to help evaluate the condition of your machine. The questionnaire and the fractured specimens must be shipped to: Charpy Program Coordinator, NIST, Division 853, 325 Broadway, Boulder, CO 80305-3328. Phone: 303/497-3351 Fax: 303/497-5939

### Location of Machine

Company \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_  
Province \_\_\_\_\_  
Zip \_\_\_\_\_  
Country \_\_\_\_\_ Postal Code \_\_\_\_\_

### Mailing Address for Verification Letter (if different from above)

Company \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_  
Province \_\_\_\_\_  
Zip \_\_\_\_\_  
Country \_\_\_\_\_ Postal Code \_\_\_\_\_

### Test Machine (Circle appropriate units where indicated)

1. Machine Manufacturer \_\_\_\_\_

2. Machine Serial Number \_\_\_\_\_

3. What is the maximum energy capacity of the machine? \_\_\_\_\_  
(Joules or ft·lbf)

4. If the machine is adjustable, what capacity was used for this test? \_\_\_\_\_  
(Joules or ft·lbf)

5. Your machine should be securely bolted to a concrete foundation or a steel block having a mass not less than 40 times that of the pendulum. Your machine should be leveled according to the requirements of the current ASTM Standard E23.

6. ASTM Standard E23 does not allow the use of expansion bolts or fasteners with driven in inserts. These types of fasteners will work loose from the foundation and tighten up against the bottom of the machine indicating a false torque value. Only J or T bolts are permitted by the standard. What type of bolts are used to mount your machine? (J, lag, etc.) \_\_\_\_\_

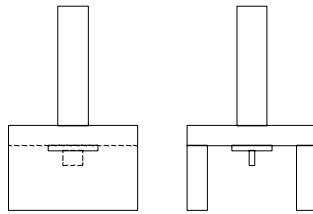
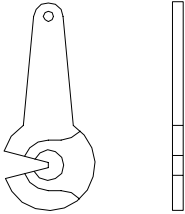
7. Is your machine equipped with a carbide striker and/or anvils? \_\_\_\_\_

8. Check the appropriate pendulum design below.

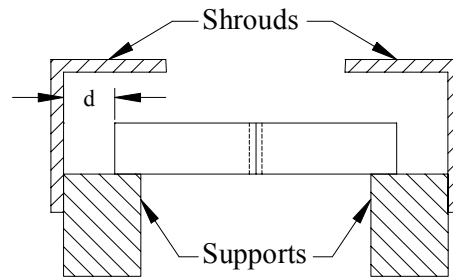
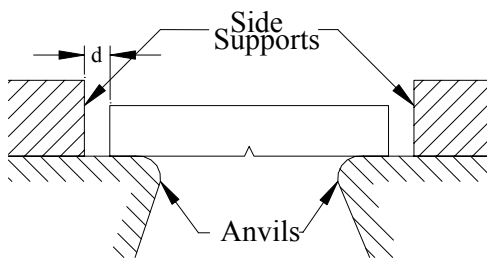
A \_\_\_\_\_

B \_\_\_\_\_

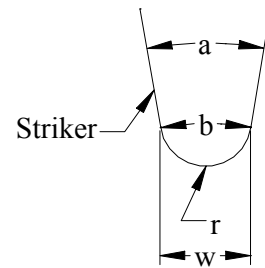
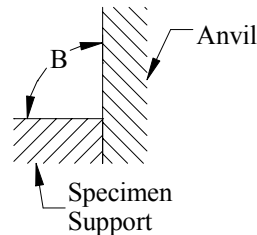
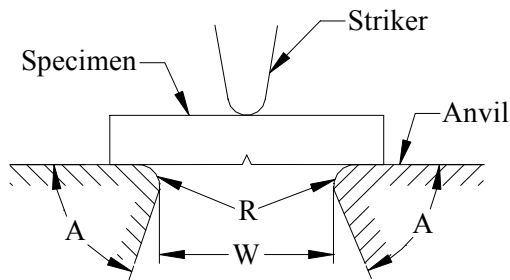
C (Other) \_\_\_\_\_  
Please Sketch



9. If side supports or shrouds are used, what is dimension “d”? \_\_\_\_\_  
(mm or in)



10. Your anvils and striker should conform to the dimensions below:

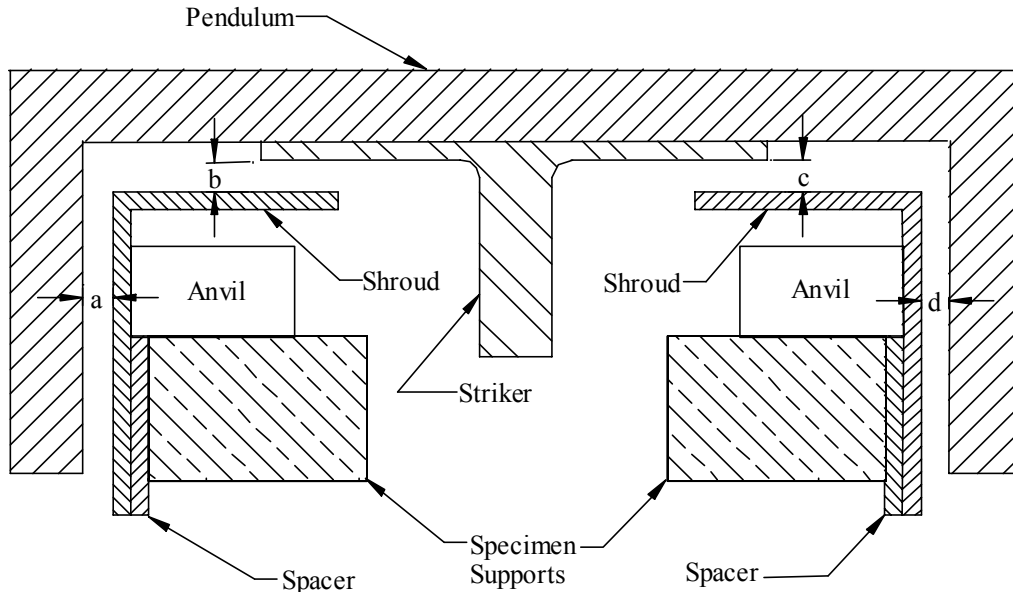


Anvils  
A: 80° approx.  
R: 1 mm  $\pm$  0.05 mm  
(0.039 in  $\pm$  0.002 in)  
W: 40 mm  $\pm$  0.05 mm  
(1.574 in  $\pm$  0.002 in)  
B: 90°  $\pm$  10 min

Striker  
a: 30° approx.  
r: 8 mm  $\pm$  0.25 mm  
(0.315 in  $\pm$  0.010 in)  
w: 4 mm approx.  
(0.157 in)  
b: 0.25 mm (0.010 in)

11. If shrouds are used to contain broken specimens, the following requirements should apply:

- (A) The shrouds should have a minimum hardness of 45 HRC.
- (B) The thickness of the shrouds should be approximately 1.5 mm (0.06 in).
- (C) Dimensions “a, b, c, and d” below should not exceed 1.5 mm (0.06 in).
- (D) If dimension “d” in item 9 is more than 13 mm (0.5 in), requirement (C) above does not apply.



12. The striker should pass through the center of the anvils within 0.40 mm (0.016 in).

13. With the pendulum in the free hanging position, engage the energy indicator. The indicator should read within 0.2 % of the maximum energy range being used.

14. What is the friction/windage loss of your machine? \_\_\_\_\_  
(Joules or ft·lbf)

(A) Raise the pendulum to the latched position. Without a specimen in the machine, release the pendulum and permit it to swing 11 half cycles; after the pendulum starts its 11th half cycle, move the pointer to between 5 to 10 % of scale range capacity and record the dial reading. \_\_\_\_\_ (Joules or ft·lbf)

(B) Divide the value by 11, then divide by the maximum scale range of the machine and multiply by 100. The result, friction and windage loss, should not exceed 0.4 %.

15. With the specimen removed from your machine and the pendulum released from its latched position, what is the dial reading after one swing? \_\_\_\_\_  
(Joules or ft·lbf)

This reading should be zero. If this reading is not zero and your machine is equipped with a compensated scale, please adjust the dial to read zero. If your machine is equipped with a non-compensated scale, please compensate the energy values for windage and friction by subtracting the windage and friction value calculated in item 13.

16. When was your machine last verified by the NIST? Date: \_\_\_\_\_

17. Is your machine equipped with a direct reading scale or a non-compensated scale? \_\_\_\_\_

## **IMPORTANT INFORMATION**

These procedures must be followed closely to obtain accurate results. The test temperature of NIST reference specimens is near the ductile-brittle transition temperature. Therefore, small differences in temperature and procedure may cause considerable variations in energy values.

- The cooling bath should be placed directly beside the machine. This enables the operator to remove specimens from the bath and fracture them in the machine quickly.
- It is very important that the specimens be removed from the bath and fractured in less than five seconds. Taking longer than five seconds can increase energy values and may cause the low energy specimens to exceed the allowable energy limit.
- If your machine is equipped with a centering device, we do not recommend that you use it to center specimens when performing low temperature testing. Instead, we recommend the use of centering tongs as described in the current ASTM Standard E23. The centering tongs must be cooled with the specimens.
- Verify temperature-measuring equipment at least twice annually. The measurement equipment can be checked immediately before the test by checking a medium with a constant temperature such as dry ice [-78.6 °C (-109.3 °F)] or ice water [0.0 °C (32.0 °F)].
- When testing super-high energy level specimens or other ductile materials, the anvils should be checked between each test for material left by the previous test.
- When the anvils are replaced it is recommended that practice specimens be broken before NIST specimens are tested.

## **DETERMINING THE USABLE RANGE OF YOUR MACHINE**

You must determine the usable range of your machine. Your machine is considered accurate only within this range. The usable range of your impact machine is dependent upon the resolution of the scale or readout device at the low end and the capacity of the machine at the high end.

The upper limit of the usable range of your machine is equal to 80 % of the capacity of the machine. If your machine is equipped with adjustable ranges, the upper limit of the range in use is equal to 80 % of the capacity of the range.

The resolution of the scale, or readout device, establishes the lower limit of the usable range for the machine. The lower limit is equal to 25 times the resolution of the scale or readout device at 15 J (11 ft·lbf).

On analog scales, the resolution is  $\frac{1}{2}$  to  $\frac{1}{4}$  of the difference between two adjacent marks on the scale at 15 J (11 ft·lbf).

The resolution of the digital readout is the smallest change in energy that can be consistently measured at 15 J (11 ft·lbf). Note that a change in the last digit of the display is usually not the resolution. The resolution of your digital readout is available from the manufacturer.

## CALCULATE THE LOWER LIMIT OF THE USABLE RANGE OF YOUR MACHINE

If your machine is equipped with a digital readout, what is the resolution? \_\_\_\_\_

If your machine is equipped with an analog scale, what is the energy value between two adjacent marks on the scale at 15 J (11 ft·lbf)? \_\_\_\_\_

What is the smallest discernable energy value readable between these marks? (This is normally  $\frac{1}{2}$  to  $\frac{1}{4}$  of the difference between two adjacent marks on the scale.) \_\_\_\_\_

Lower usable limit of your machine. Multiply the above finding by 25. \_\_\_\_\_  
Joules or ft·lbf

## YOU SHOULD NOT USE YOUR MACHINE TO PRODUCE DATA BELOW THIS ENERGY VALUE.

Example 1: (Digital Readout)

You have a machine with a capacity of 407 J (300 ft·lbf) and your machine is equipped with a digital readout. The resolution of the readout is 0.14 J (0.1 ft·lbf) at 15 J (11 ft·lbf). The lower limit of your machine is 25 times 0.14 J (0.1 ft·lbf) or 3.5 J (2.6 ft·lbf).

Example 2: (Analog Scale)

You have a machine with a capacity of 407 J (300 ft·lbf) and your machine is equipped with an analog scale. The energy value between the marks at 15 J (11 ft·lbf) is 0.68 J (0.50 ft·lbf). You should be able to estimate to at least 0.34 J (0.25 ft·lbf). This is your resolution. Multiply by 25. The lower limit of your machine is 8.47 J (6.25 ft·lbf).

## TESTING TECHNIQUE

1. Test temperature for SRM 2092 low energy and SRM 2096 high energy level specimens must be  $-40\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$  ( $-40\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$ ).
2. **IMPORTANT:** Test temperature for SRM 2098 super-high energy level specimens must be  $21\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$  ( $70\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$ ).
3. How long were the specimens held at temperature? (NIST recommends a minimum of 10 minutes) \_\_\_\_\_
4. What instrument was used to remove the specimens from the bath and center them in the machine? \_\_\_\_\_

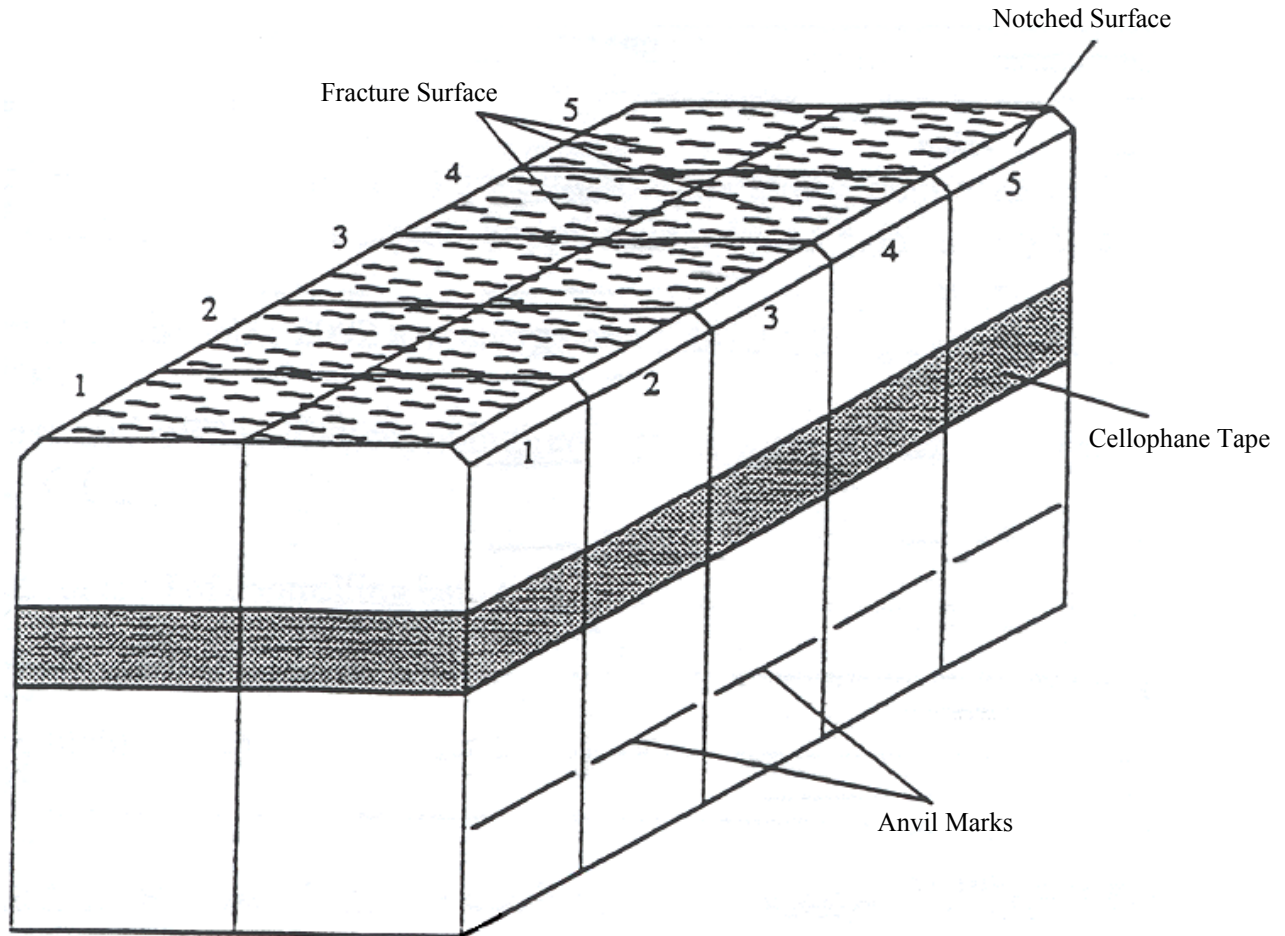
## STATE THE REASON FOR VERIFICATION

1. Compliance with annual ASTM Standard E23 Indirect Verification \_\_\_\_\_
2. Changed striker and/or anvils \_\_\_\_\_
3. Moved machine \_\_\_\_\_
4. Changed bearings or pendulum \_\_\_\_\_



## WRAPPING INSTRUCTIONS

To expedite the evaluation of your machine, please secure the 5 broken specimens (10 halves) from a particular energy series, as one unit with **clear cellophane tape** according to the following instructions. See diagram below.



1. Keep broken halves correctly paired (back to back) with the fracture surfaces facing upward and notched surfaces facing outward.
2. Coat the **FRACTURE SURFACES ONLY** with a light coat of oil. **DO NOT** use grease or coat in plastic.
3. Include this completed questionnaire with the fractured specimens.
4. Be sure that you use the **MAILING LABEL** provided with the specimens, and attach the label so that it is clearly displayed on the **OUTSIDE** of the package. This will expedite delivery to the Charpy Coordinator. Customers returning specimens from outside the United States should include the following statement on the U.S. Customs Declaration:  
**Contents include U.S. manufactured steel test bars being returned to the U.S. for evaluation and are valued at less than 10 U.S. dollars.**

## CUSTOMER SERVICE QUESTIONNAIRE

I am pleased with the specimen ordering and shipping process (the process of getting the specimens and the instructions for testing).

	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	

I am pleased with the evaluation process (the process of returning the specimens and data for the comparison to the requirements of the current ASTM Standard E23, and obtaining a verification letter and machine sticker).

	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	

I am pleased with my interactions with the Charpy Coordinator (customer service).

	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	

I am pleased with the quality of the specimens.

	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	

What suggestions do you have for further improvements to the service?

## TEST RESULTS

INDICATE ENERGY UNITS (circle units used)

**Joules or ft·lbf**

Series _____ SRM 2092		Series _____ SRM 2096		Series _____ SRM 2098	
Specimen Number	Value	Specimen Number	Value	Specimen Number	Value
Average Value		Average Value		Average Value	

Date of Test \_\_\_\_\_  
(Month/ Day/ Year)

\_\_\_\_\_  
PRINT Test Operator

Telephone \_\_\_\_\_

Fax \_\_\_\_\_

\_\_\_\_\_  
SIGNATURE Test Operator

Email \_\_\_\_\_

\_\_\_\_\_  
PRINT Company Representative

Telephone \_\_\_\_\_

Fax \_\_\_\_\_

\_\_\_\_\_  
SIGNATURE Company Representative

Email \_\_\_\_\_

If you require approval of your machine by the Defense Contract Management Command (DCMC), a DCMC representative should provide his or her **signature and the DCMC seal** to indicate that the preceding information was witnessed by a government representative.

\_\_\_\_\_  
Print Name of DCMC Official

DCMC Seal

\_\_\_\_\_  
Signature of DCMC Official and Seal

\_\_\_\_\_  
DCMC Office Location